BACHARACH®

INSTRUCTION 77-9045
AUDIT PROCEDURES FOR
INJECTOR CALIBRATOR CD3
USING CD3 AUDIT KIT
Part Number 67-7707
Installation/Operation/Maintenance
Rev. 1 - February, 1994

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NOTE: *Fuses and gaskets are expendable items and are excluded from the terms of this warranty.*

CONTENTS

Warranty
Contents i
Important Notes ii

l.0 Introduction 1-1
1.1 Tools and Equipment Required for Complete Audit 1-2
1.2 Installing Batteries 1-3
1.3 Preparation for Audit 1-3
1.4 Pre-Audit Checklist 1-5

2.0 Cummins Injectors 2-1
2.1 Calibrator RPM Test 2-1
2.2 Calibration Fluid Viscosity Check 2-4
2.3 Calibration Fluid Temperature Test 2-5
2.4 Gear Pump Pressure Check 2-7
2.5 Discharge Head Check 2-9
2.6 Flowmeter Check 2-14
2.7 Body to Seat Clamp Force Test 2-16
2.8 Plunger to Body Clamp Force Test 2-18
2.9 Injector Supply Pressure 2-20
2.10 Stroke Count Check 2-22

3.0 Detroit Diesel Engine (DD) Injectors 3-1
3.1 Calibrator RPM Test 3-1
3.2 Calibration Fluid Viscosity Check 3-4
3.3 Calibration Fluid Temperature Test 3-4
3.4 Flowmeter Check 3-4
3.5 Plunger to Body Clamp Force Test 3-4
3.6 DD Master Injector Flow Test 3-5
3.7 Stroke Count Check 3-6

4.0 Post Audit Checklist 4-1

5.0 Spare Parts 5-1
5.1 Major Assemblies 5-1
5.2 Individual Replacement Parts 5-2

IMPORTANT NOTES

l. Before auditing your CD3 calibrator, determine whether or not your calibrator has a relief valve to adjust the injector supply pump pressure. CD3 calibrators manufactured after November 1984 incorporate this valve. See photograph at right.

The relief valve fits on the end of a length of plastic tubing leading from a brass cross fitting at the injector supply pump. The relief valve is normally inserted into the calibration fluid reservoir through 8 hole in the top of the reservoir.

If necessary, install the relief valve be£ore starting the audit. A Relief Valve Kit, consisting of all the necessary parts and installation instructions, is available for customer installation. The kit can be ordered from Bacharach using part number 77-0452.

2. The list of tools and equipment required to perform an audit is in Section 1.1. Make certain you have them before starting the audit.

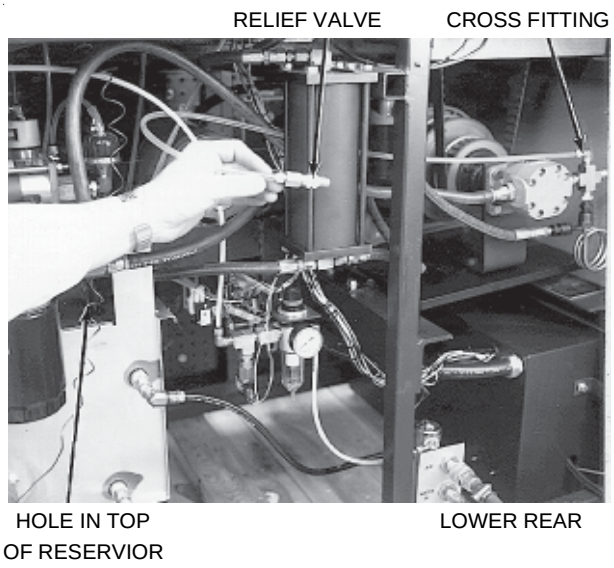


Figure 1. Relief Valve

1.0 INTRODUCTION

The Bacharach Injector Calibrator Model CD3 calibrates and tests mechanical unit injectors manufactured by Diesel Technology Corporation (used in Detroit Diesel engines (DD)) and by Cummins Engine Company. The CD3 has been adjusted, set, and tested at the factory to ensure accurate test results. It is a precision machine and must be handled accordingly.

To maintain the calibrator at its peak performance, Bacharach provides an Audit Kit for checking most critical components and systems.

The Audit Kit consists of the following items:

- Dead weight tester
- Test gauge set
- Viscor cup with its associated instructions and chart
- Dummy injector assembly
- Clamp force and temperature indicator*
- Temperature transducer assembly*
- Load cell assembly*
- Rail pressure gauge adjusting tool
- Graduated cylinder
- Tubing with quick connects
- Splash shield cup
- Hose

---

*The clamp force and temperature indicator is calibrated with its load cell and temperature transducer. (They are calibrated, the serial numbers recorded, and become a matched set at the factory.) If the load cell or transducer are replaced, the clamp force and temperature indicator must be recalibrated.

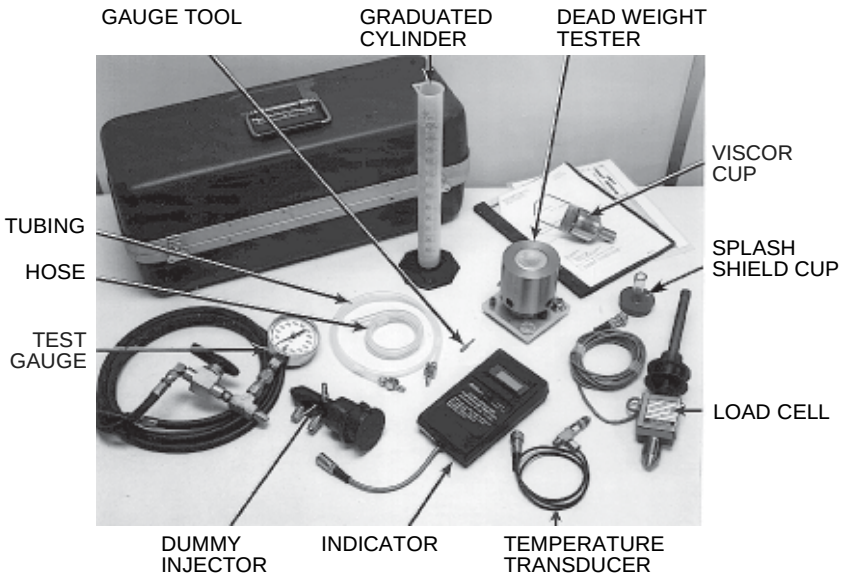


Figure 1-1. Audit Kit

The test and measurements that can be performed with the Audit Kit are:

- Calibration fluid viscosity
- Calibration fluid temperature
- Injector supply gear pump pressure
- Injector supply inlet pressure
- Body-to-seat clamping force
- Plunger-to-body clamping force
- Discharge head performance
- Flowmeter performance

Additional tests needed for a complete audit are:

- Speed check of the calibrator camshaft
- Stroke count check
- Plow test using DD master injectors (for DD injectors only)

Each of these tests and checks influence the performance of the CD3. Therefore, each procedure must be followed and all requirements met as stated.

These audit procedures may be performed for Cummins injectors only or for DD injectors only, or for both. To ensure good results, the procedures must be performed in the order listed.

1.1 TOOLS AND EQUIPMENT NEEDED FOR COMPLETE AUDIT

In addition to the Audit Kit (67-7707), tools and equipment needed for a complete audit are:

- One set of open end wrenches 3/8 in. to 1-1/8 in.
- Screwdriver, 9/32 in. tip width, stub 3-1/2 in.
- Screwdriver, 6 in. blade, 5/16 in. tip
- Screwdriver, 3 in. blade, 3/16 in. tip
- A1len key wrench set 5/64 through 1/4 in.
- Stop watch - 0.1 second readability

- Digital tachometer (hand held). Photo-electric unit preferred, mechanical (contact type) acceptable (readability: ±1 digit)
- Cummins injector, flow code 178A
- Master injector kit, Kent Moore part no. J-26298 (53,71,149)
- Master injector, Kent Moore part no. J-29898 (8.2L)
- Two fresh 9 volt alkaline batteries Duracell M1604, Eveready 522 or others meeting NEDA-1604A specifications). Operating life of the batteries is approximately 6 continuous hours.
- Container - minimum 2 quart, maximum 8 quart, with minimum 3 in. diameter opening and minimum 6 in. high

1.2 INSTALLING BATTERIES

1. Make certain that the clamp force and temperature indicator is turned off.
2. Remove the battery cover.
3. Connect two 9 Volt batteries to the terminal clip.
4. Insert the batteries into the holder.
5. Close the cover.

CAUTION

Leaks from batteries can damage the indicator. Remove dead batteries promptly. Also remove batteries if the indicator will not be used for a long time.

If the display indicates "LO BAT," the display values may be inaccurate.

1.3 PREPARATION FOR AUDIT

1. Clean the work area. Contaminants will interfere with the audit.
2. Make sure all air lines are intact and contain no water or particulate matter.

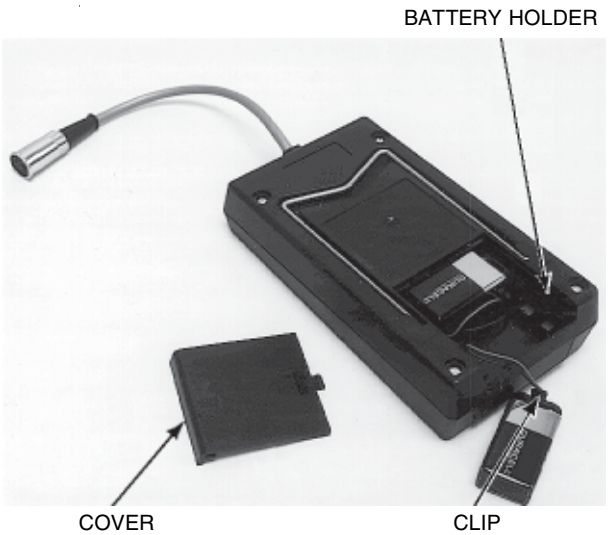


Figure 1-2. Battery Holder

3. Replace fluid and filters in the calibration fluid system.

   NOTE: *Save approximately 2 quarts of calibration fluid from the same batch as fluid in step 3. Store in a clean container to use when checking viscosity (Section 2.2).*

4. Make sure all calibration fluid lines are intact and clean.

5. Replace any worn components such as belts, pulleys, and couplings.

6. Check and fill, if necessary, the lube oil in the air-driven hydraulic pump.

7. Make sure the water, air and electrical utilities meet specifications listed in the Injector Calibrator CD3 Installation/Operation/Maintenance Instruction (67-9319).

8. Operate the calibrator with an injector in place for 30 minutes before beginning the audit. This will circulate new fluid and remove any contaminants that may be in the lines.

9. Use the following checklist to complete the preparation for the audit.

1.4 PRE-AUDIT CHECKLIST

All responses to the following checklist should be "YES".

Pre-audit Checklist	YES	NO
Calibration Fluid Reservoir Cleaned	_____	_____
New Calibration Fluid Filters*	_____	_____
New Calibration Fluid in Reservoir*	_____	_____
Calibration Fluid Reservoir Full*	_____	_____
New "O" Ring in Fuel Arm*	_____	_____
Intensifier Reservoir Full*	_____	_____
Cam Box Oil Changed*	_____	_____
Cam Box Oil Level Normal*	_____	_____
No Leaks in Calibration Fluid Systems	_____	_____
Foreign Objects Removed From Work Area	_____	_____
Air Supply Connected*	_____	_____
Water Supply Connected*	_____	_____
Flowmeter Transducer Reservoir Filled*	_____	_____
Electrical Supply Correct for the Calibrator being Audited (check the Nameplate)*	_____	_____
Fresh Batteries Installed in clamp force and temperature indicator	_____	_____

*These procedures are in the instruction manual for the CD3 Calibrator (part 67-9319).

NOTES

2.0 CUMMINS INJECTORS

This section describes procedures designed to adjust the CD3 for accurate testing of Cummins injectors. These procedures must be performed in the sequence listed here. After doing the viscosity check (Section 2.2), complete the rest of the procedures while the fluid and the machine are warm. While performing these procedures, be certain all fluid connections for each test are intact.

2.1 CALIBRATOR RPM TEST

This test ensures that the injectors are driven at the correct speed. Because the main motor is synchronous, the speed of the camshaft depends only on incoming power frequency and pulley ratio. As long as the frequency is held to 60 Hz (or 50 Hz, depending on the motor used), the speed will fall within the prescribed range. If an injector is driven at a speed lower than prescribed, its flow output will increase because the absolute time for filling the injector is increased. If the injector is driven at a higher speed, its output will decrease.

Equipment Required

- Hand held digital tachometer, optical preferred
- Screwdriver (small stubby)

2.1.1 Using a Photo-Electric Tachometer

Set-up

1. Switch circuit breaker OFF.

2. Open the pulley cover.

   NOTE: *Older units use a sliding pulley cover, which should be opened ½ inch.*

3. Attach a small piece of reflective tape (usually supplied with the tachometer) to the front flywheel face so that it can be seen through the perforated window.

   NOTE: *The white painted strip on the flywheel can be used instead of the tape. The painted strip can be viewed through the perforated window.*

4. Close pulley cover.

Test

5. Set up the calibrator for running a Cummins 3/8 PTD (or similar) injector per the CD3 calibrator instruction manual.

6. Turn circuit breaker on side of calibrator ON.

7. Press the START button.

8. Aim tachometer lightbeam at perforated window and read RPM. (Consult tach. instructions if any problems with reading occurs.)

9. Record reading.

10. Press the STOP button.

11. If RPM is 1050 ±1 rpm, skip to step 13.

12. If RPM is not 1050 ±1 rpm:

    a. Make sure the motor matches the line frequency (see specifications on the nameplate inside left side door).

    b. Operate the calibrator without an injector installed and without push rod adapters.

    c. Recheck the speed with a tachometer.

    d. If problems still exist, check the drive shaft, pump shaft or motor shaft binding and replace necessary parts.

13. If speed is normal, turn circuit breaker OFF.

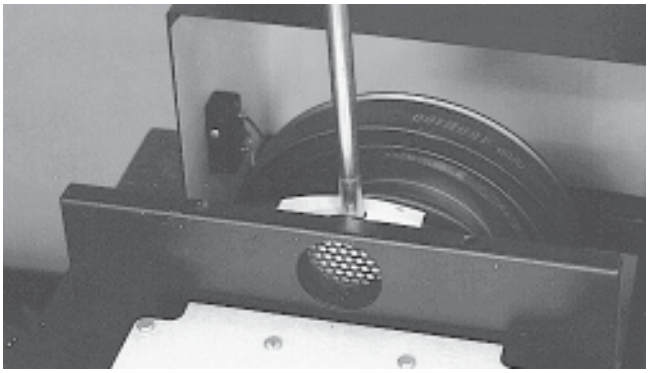


Figure 2-1. Using Tachometer

Ë CAMSHAFT CENTER HOLE

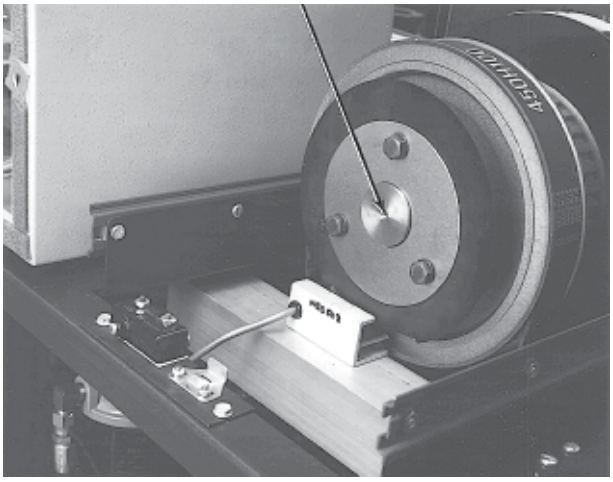


Figure 2-2. Camshaft Center Hole

2.1.2 Using a Mechanical Tachometer

Set-up

1. Switch circuit breaker OFF.

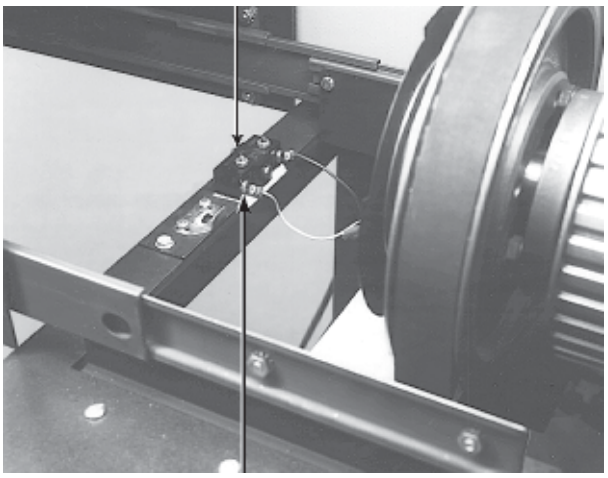
2. Remove the pulley cover.

   NOTE: *Older units (shown in the photos) use a sliding pulley cover (newer units have no side rails), slide the cover backward until the track is disengaged.*

3. Stand behind calibrator and locate camshaft center hole on the end of the camshaft. This is where the tachometer will be held during test.

4. Find the cover interlock limit switch on the calibrator table top, just behind the drive shaft next to the cover latch plate.

Ì LIMIT SWITCH



Í RIGHT TERMINAL SCREW

Figure 2-3. Limit Switch

5. Remove wire in center terminal of the switch and reconnect it to right terminal screw of switch (as viewed from rear of the calibrator).

Test

6. Set up calibrator for running a Cummins 3/8 PTD (or similar) injector per the CD3 calibrator instruction manual.

WARNING

HAZARDOUS ROTATING EQUIPMENT. Do not reach over the pulley to operate the START or STOP buttons. Walk around to the front of calibrator. Be careful not to entangle loose clothing (such as sleeves and neckties) in rotating equipment.

7. Turn the circuit breaker on the side of the calibrator ON.

8. Press the START button.

9. Press end of the tachometer shaft against back end of the camshaft and read RPM. Keep the tachometer aligned with the camshaft. Make sure that the center of the camshaft is oil-free. Oil on the camshaft will cause the tachometer shaft to slip. Inaccurate readings will result.

10. Record reading.

WARNING

HAZARDOUS ROTATING MACHINERY. Do not reach over the camshaft to turn off the calibrator.

11. Go to front of calibrator and press STOP button.

12. If RPM is 1050 ±1 rpm, skip to step 14.

13. If RPM is not 1050 ±l rpm:

    a. Make sure the motor matches the line frequency (see specifications on the name-plate inside left side door).

    b. Operate the calibrator without an injector installed and without push rod adapters.

    c. Recheck the speed with a tachometer.

Ñ TACHOMETER

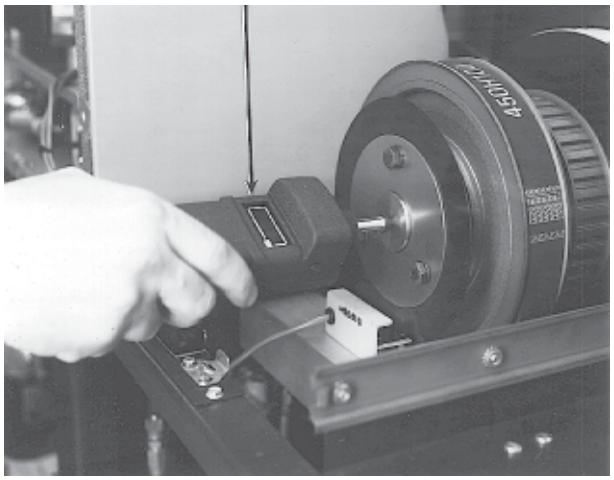


Figure 2-4. Using Mechanical Tachometer

d. If problems still exist, check the drive shaft, pump shaft or motor shaft binding and replace necessary parts.

14. If speed is normal, turn circuit breaker OFF.

15. Reinstall the wire on the interlock limit switch in its original position at the center screw.

16. Reinstall the pulley cover.

17. Turn the power switch on the side of the calibrator to ON.

18. Push the START MAIN DRIVE button on the front of the calibrator.

19. While the calibrator is operating, open the pulley cover.

NOTE: *For older units use a sliding pulley cover, slide the cover ½ inch toward the back of the stand.*

The calibrator will stop automatically if wiring is correct and the system is functioning properly.

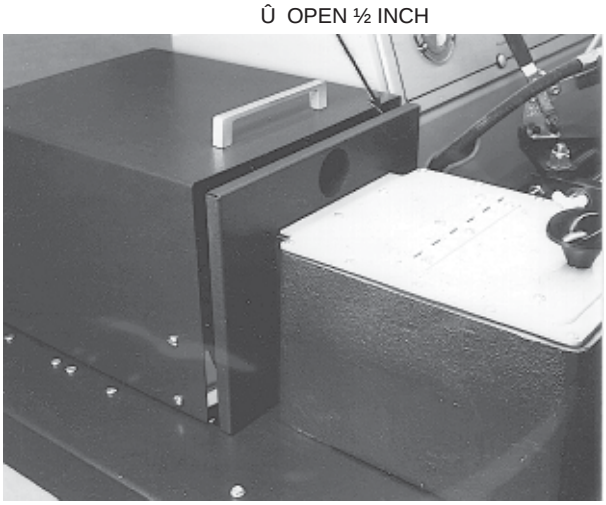


Figure 2-5. Opening Pulley Cover

2.2 CALIBRATION FLUID VISCOSITY CHECK

Viscosity of the calibration fluid has a marked influence on the flow test of an injector. Note that viscosity changes with fluid temperature. This test applies only to fluid specified in the CD3 manual.

Equipment Required

- Viscor cup with instructions and chart (Make sure the number on the chart and instructions match the number on the cup.)
- Temperature transducer assembly
- Clamp force and temperature indicator
- Container - Minimum 2 quart, maximum 8 quart, with minimum 3 in. diameter opening and maximum 6 in. high
- Stop watch

Setup

1. If calibration fluid was not saved when preparing for audit (Section 1.3), drain a minimum of 1-½ quarts of calibration fluid from reservoir into a clean, dry container - Minimum depth 5 inches.

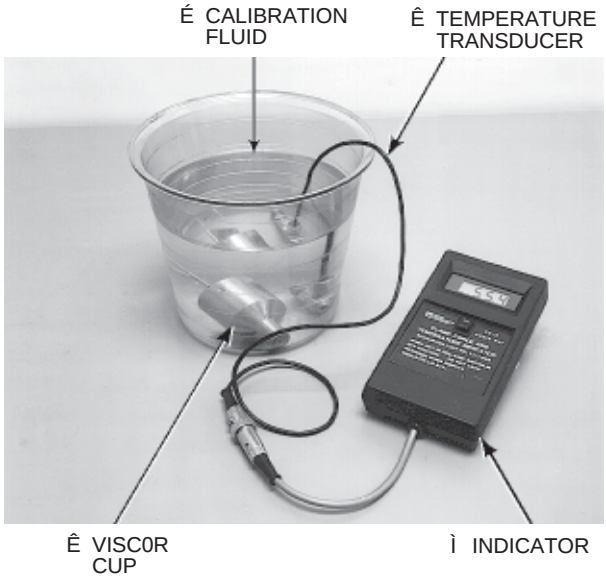


Figure 2-6. Fluid Viscosity Check

2. Immerse the Viscor cup and temperature transducer in the fluid in the container.

3. Allow a minimum of one hour for the temperature of the fluid, cup, and transducer to stabilize at room temperature.

4. Connect the temperature sensor cable to the clamp force and temperature indicator.

Test

5. Follow the instructions supplied with the Viscor cup.

6. Return contents of the container to the fuel reservoir, clean the equipment and return the items to the Audit Kit case.

7. Leave the temperature sensor connected to the clamp force and temperature indicator. Turn off the indicator.

2.3 CALIBRATION FLUID TEMPERATURE TEST

Maintaining the correct calibration fluid temperature at the injector inlet is important because the fluid temperature has a marked influence on delivery.

Equipment Required

- Clamp force and temperature indicator
- Temperature transducer assembly
- Cummins, Flow Code 178A injector

Set-up

1. Turn the circuit breaker on the side of the calibrator to ON.

2. Allow time for calibration fluid to reach the set temperature.

   NOTE: *Allow the HEATER ON indicator (located on front panel just below the CALIBRATION FLUID TEMPERATURE gauge) to cycle ON and OFF several times before proceeding.*

3. Connect the temperature transducer in line with the fuel arm supply line hose.

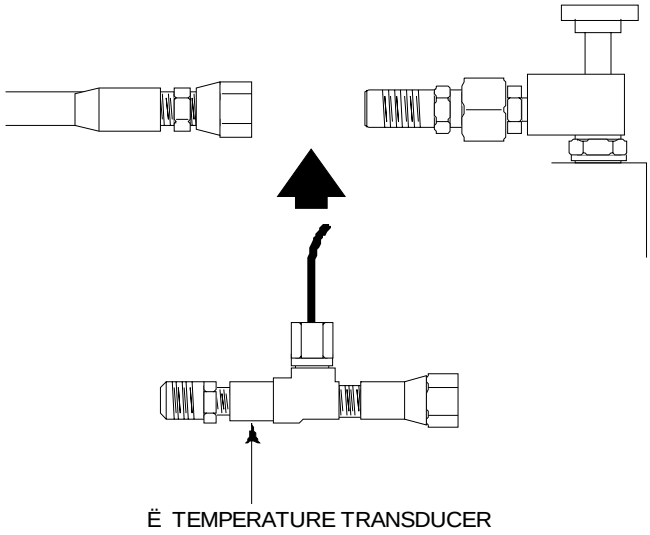


Figure 2-7. Temperature Transducer

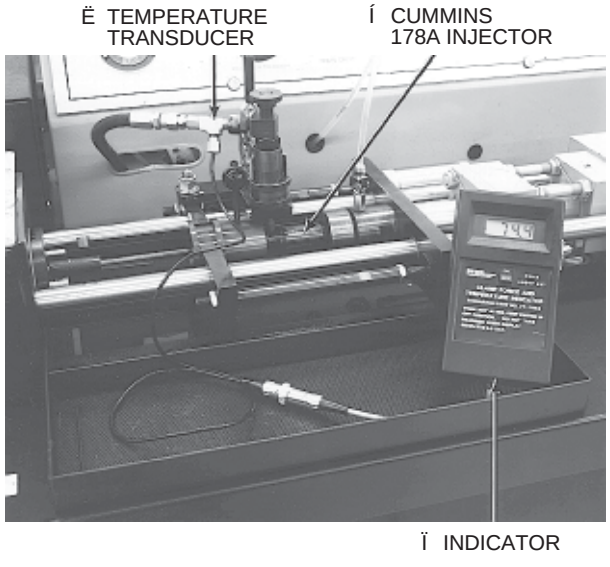


Figure 2-8. Transducer Installation

4. Set up calibrator for a Cummins PTD injector. (See the CD3 calibrator instruction manual.)

5. Install a Flow code 178A injector.

6. Operate the calibrator for 15 minutes.

Test

7. After 15 minutes, turn on the clamp force and temperature indicator and observe the temperature of the fluid. It should be 104°F ± 1°F, while the injector is running.

8. If the clamp force and temperature indicator plus the temperature gauge read the same (104°F ± 1°F):

   a. Disconnect the temperature transducer from the clamp force and temperature indicator.

   b. Reconnect the supply line to the fuel arm.

   c. Skip to Section 2.4. You are finished with this test.

9. If the temperature is not 104°F ± 1°F, continue with the following steps.

10. Loosen the lock nut on the TEMPERATURE ADJUSTMENT control, located on the gauge panel just below the HEATER ON indicator.

11. Adjust the TEMPERATURE ADJUSTMENT control until the clamp force and temperature indicator display stabilizes at 104°F ± 1°F.

    NOTE: *It takes time for fluid in the reservoir to mix and the temperature to stabilize. A small change in TEMPERATURE ADJUSTMENT setting will stabilize much faster than a large adjustment.*

12. After the fluid temperature has stabilized at 104 °F ± 1°F, recheck the temperature indicated on the CAL FLUID TEMPERATURE gauge.

13. If the gauge and the indicator read the same (within 1°F), perform the procedures in step 8. If not:

    a. Unscrew the plastic cover on the temperature gauge.

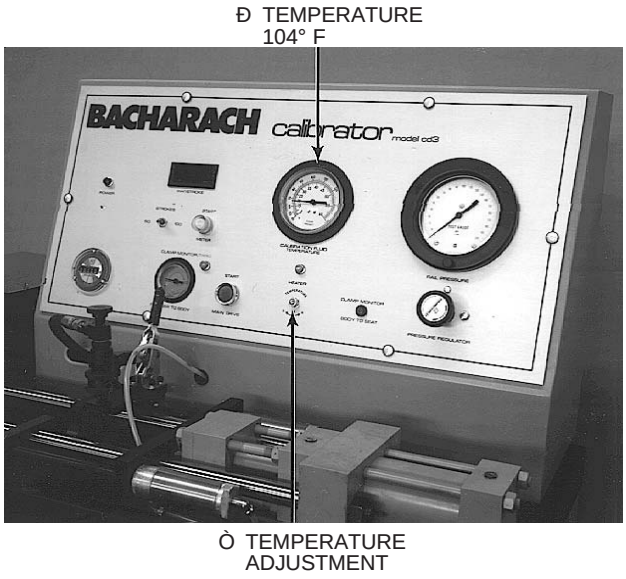


Figure 2-9. Temperature Adjustment

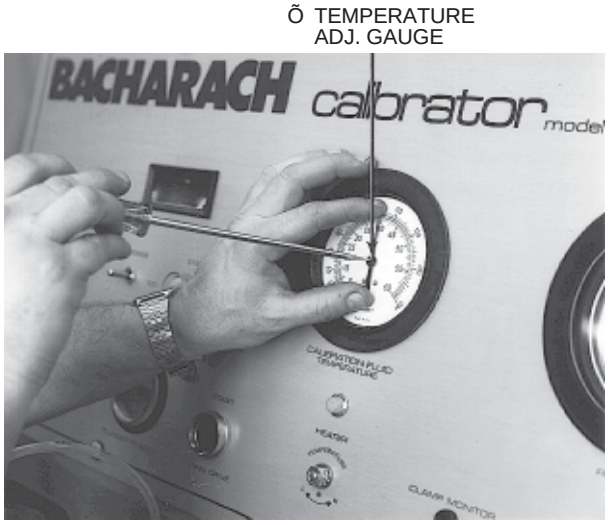


Figure 2-10. Temperature Gauge

b. Hold the pointer with your fingers and adjust the pointer screw to read the same as the clamp force and temperature indicator.

c. Replace the gauge cover.

NOTE: *When set properly, temperature indicator and temperature gauge will read the same (within ± 1°F).*

14. If the temperature varies more than ± 1°F:

a. Check the calibration fluid level. It should be at FULL on the dipstick.

b. Check the water flow at the water outlet. It should flow freely when the amber light on the front panel is not lit.

c. Check the heater elements in the calibrator fluid reservoir.

15. If the calibrator fluid temperature still cannot be maintained within ± 1°F, the following components on the CD3 may be defective:

a. Temperature controller.

b. Temperature adjustment control.

c. Temperature sensor in fuel reservoir.

d. Dial thermometer and/or its bulb.

16. Repair or replace these components if necessary, then repeat the calibration fluid temperature test.

17. After completing the temperature test:

a. Remove the temperature transducer.

b. Reconnect the supply line to the fuel arm.

2.4 GEAR PUMP PRESSURE CHECK

Gear pump pressure must be maintained at 400 to 410 psi to keep the supply system well pressurized, to reduce pulsations and to provide a steady fluid supply to the injector.

Make sure the relief valve for adjusting the injector supply pump pressure is installed before proceeding with this check. For details, see the **Important Notes** section in the front of this manual.

Equipment Required

- Test gauge set

Set-up

1. Remove the injector, push rod link, and push rod extension.

2. Open the door on the left side of the calibrator.

3. Connect the test gauge set to the high pressure line quick connect. The fitting is located at the pump driven by the main drive motor shaft.

4. Close the valve on the test gauge (black handle across valve body).

   NOTE: *Be certain that the test gauge hose does not interfere with drive belts.*

Test

5. Run the calibrator. (Push the START MAIN DRIVE button.)

6. Set the rail pressure gauge on the front panel for 100 psi.

7. Check for any leakage in fluid lines or fuel arm. Repair if necessary.

8. Open the valve on the test gauge set (black handle in line with valve body). Pressure should be between 400 and 410 psi.

9. If pressure is between 400 and 410:

   a. Stop the main drive motor.

   b. Wait until pressure gauge needle returns to zero.

   c. Skip the rest of this procedure and proceed to Section 2.5.

10. If pressure is not between 400 and 410 psi:

    a. Stop the main drive motor.

    b. Recheck the fluid level, fluid lines and pump drive components for any problems. Refill or repair if necessary.

    c. Rerun the test (step 8).

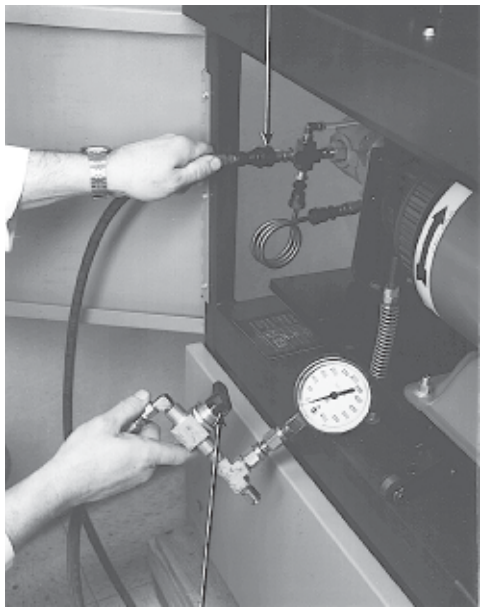


Figure 2-11. Gear Pump Pressure Setup

Figure 2-12. Set Rail Pressure

11. If, after rerun, pressure is not between 400 and 410 psi, adjust the relief valve:

    a. Stop the main drive motor.

    b. Open the valve on the test gauge set.

    c. Follow the clear plastic tubing from the fitting at the high pressure pump to the calibration fluid tank under the calibrator.

    d. Lift the pressure relief valve (on the end of the plastic tubing) out of the reservoir.

    e. Adjust the set screw from the open end of the relief valve with a 5/32 in. Allen wrench. First, loosen or remove the locking screw. Then, turn the screw clockwise to increase the pressure, counterclockwise to decrease the pressure. Retighten the locking screw.

       NOTE: *One quarter turn will result in approximately a 25 psi change.*

    f. Insert the tubing with the relief valve into the reservoir.

    g. Restart the main drive motor.

    h. Check the pressure reading on the test gauge set.

    i. Repeat steps d through h as often as necessary to bring the pressure into the required 400 to 410 psi range.

12. If pressure is below 400 psi and cannot be adjusted with the relief valve, the problem may be either with the valve or the gear pump. Replace defective part and rerun steps 11g and 11h.

13. Repeat step 9.

Ð OPEN VALVE

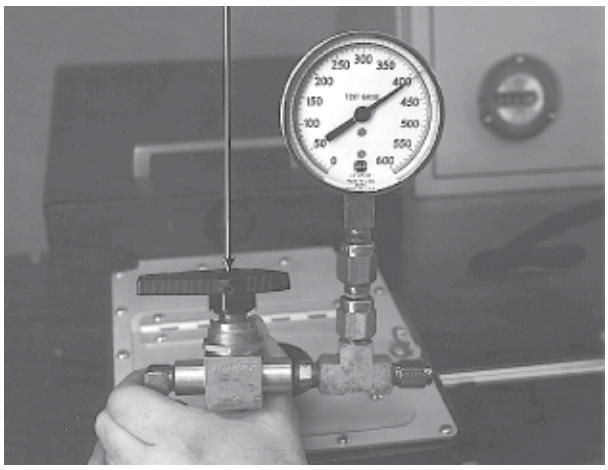


Figure 2-13. Open Valve

Ó ADJUST RELIEF VALVE

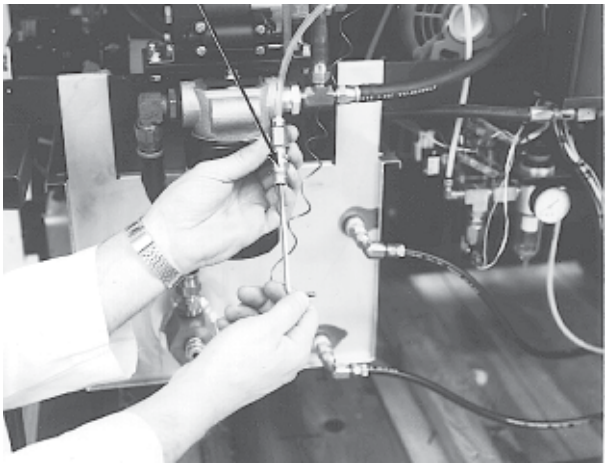


Figure 2-14. Adjusting Relief Valve

2.5 DISCHARGE HEAD CHECK

Performance of the discharge head (67-7642) has a pronounced effect on Cummins injector output readings. The check valve in the head was designed to close immediately after each injection to prevent fuel backflow and permit buildup of correct upstream pressure. Any deviation from the prescribed specification will alter the injector fuel output.

Three tests need to be performed on the discharge head:

- Upstream leakage
- Pressure drop
- Downstream leakage

Equipment Required (for All Three Tests)

- Test gauge set
- Dummy injector
- Connecting tubing with quick connects
- Splash shield cup with hose
- Stopwatch

2.5.1 Upstream Leakage Test

Set-up

1. Unclamp the body from the seat, if clamped.

2. Disconnect flowmeter tubing from the top of the discharge head.

3. Remove the discharge head and set it on the drain tray.

4. Wipe off any excess fluid from all discharge head surfaces. Connect the test gauge set to the high pressure line quick connect (Section 2.4, step 3). The fitting is located at the pump driven by the main drive motor shaft.

5. Connect the end of the plastic tubing to the test gauge set. Insert the other end into the quick connect of the discharge head.

6. Close the valve on test gauge set (black handle at a right angle to the flow of fluid in tubing).

7. Push the START MAIN DRIVE button.

Test

8. Slowly open the valve on the test gauge set until the pressure reaches maximum. It should be equal to the value found or set in Section 2.4, Gear Pump Pressure Check.

9. If pressure is below 400 psi:

   a. Recheck gear pump pressure (see Section 2.4).

   b. Verify that gauge is still calibrated.

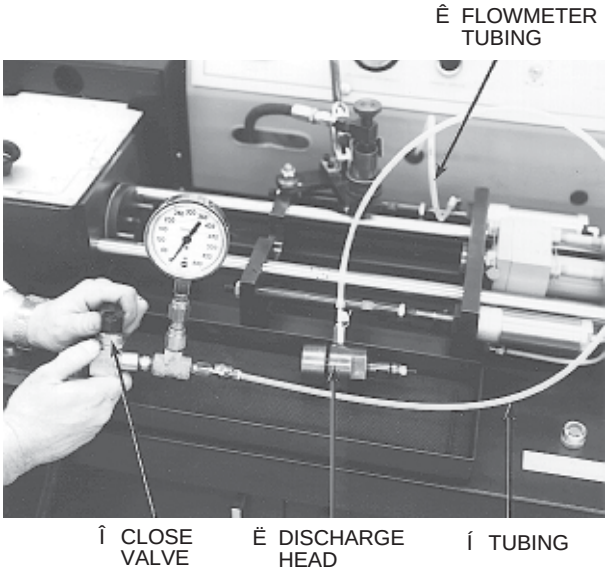


Figure 2-15. Upstream Leakage Test Set-up

c. If pressure is still low after checking out the gauge, there must be a leak. Find and correct it before continuing with the procedure.

10. If pressure is between 400 and 410 psi:

    a. Check for external leakage of discharge head, especially around the adjustment screw, and sealing nut.

       NOTE: *Older Units contain a locknut and metal-rubber sealing washer, these should be replaced with the new sealing nut supplied with the Audit Kit.*

       If a leak is found, replace sealing nut, but do not disturb adjusting screw. If external leak is not evident proceed.

    b. Close the valve on the test gauge set.

    c. Begin timing with a stop watch. Pressure on the gauge fixture should not fall below 350 psi before 60 seconds.

11. If pressure drops below 350 psi before 60 seconds:

    a. Check all lines and fittings in supply system for leaks.

    b. Replace the sealing nut on back of the discharge head.

    c. Replace the discharge bead.

12. Turn off the main drive. (Push the STOP button.)

2.5.2 Pressure Drop Test

Set-up

NOTE: *Connecting tubing is under pressure. Use a rag as a shield against squirting oil.*

1. Disconnect connecting tubing from the test gauge set.

2. Install the discharge head so that the outlet fitting is directed into the drain tray.

3. Place the splash shield cup and short tube under the discharge head outlet fitting.

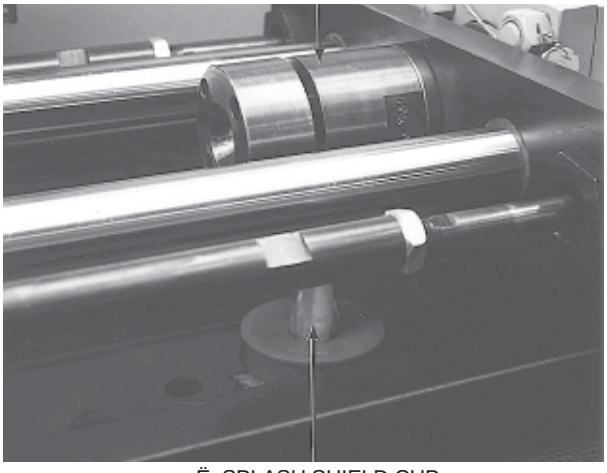


Figure 2-16. Pressure Drop Set-up

4. Install the dummy injector.

5. Clamp the dummy injector body to the seat.

6. Connect the test gauge set to the quick connect fitting on the right side of the dummy injector.

7. Close the valve on the test gauge set.

8. Start the main drive. (Push the START MAIN DRIVE button.)

Test

9. Open the pressure test gauge set valve completely. Pressure should be 150 psi +20, -0 psi with fluid flow down through the outlet fitting.

   NOTE: *Cracking pressure of the valve will usually be higher than 150 psi +20, -0 psi.*

10. If pressure reading remains at 150 psi +20, -0 psi, skip to Section 2.5.3.

11. If pressure is too high, too low, or if there is no flow:

    a. Turn off the main drive. (Push the STOP button.)

    b. Close the pressure test gauge set valve.

    c. Unclamp the body from the seat.

    d. Remove the dummy injector.

    e. Remove the discharge head.

    f. Remove the sealing nut on the end of the discharge head.

       NOTE: *Older Units contain a locknut and metal-rubber sealing washer, these should be replaced with the new sealing nut supplied with the Audit Kit.*

    g. Replace the sealing nut with a new one, supplied with the Audit Kit.

    h. Reinstall, but do not tighten, the sealing nut on the end of the discharge head.

    i. Turn Allen screw one-half turn counterclockwise to lower pressure reading (clockwise to raise it). If there is no flow, turn Allen screw about one full turn counterclockwise.

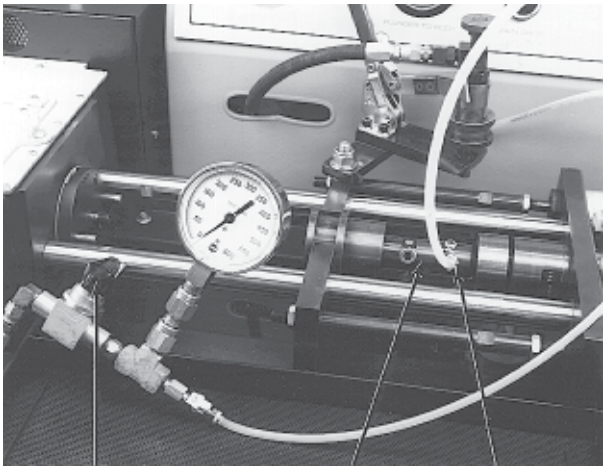


Figure 2-17. Pressure Drop Set-up (cont.)

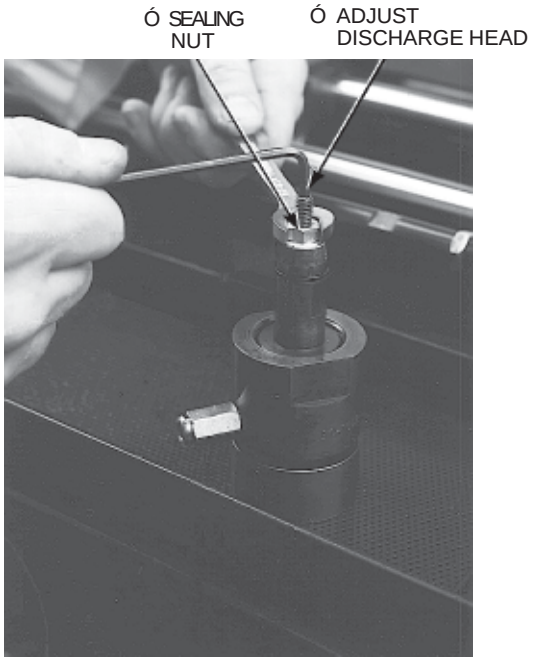


Figure 2-18. Discharge head Adjustment

j. Tighten the sealing nut while preventing the Allen screw from moving.

12. Reinstall the discharge head and dummy injector.

13. Reclamp the injector body to the seat.

14. Start the main drive (push the START MAIN DRIVE button).

15. Recheck pressure drop as in step 9.

16. If pressure is not within limits, repeat Steps 11 through 15 (except for replacing the sealing nut on the discharge head).

17. Stop the main drive (push the STOP button).

18. After making pressure drop adjustments, repeat the “Upstream Leakage Test", Section 2.5.1.

2.5.3 Downstream Leakage Test

Set-up

The set up for the “Downstream Leakage Test" is the same as described in Section 2.5.2, "Pressure Drop Test Set-up”.

Test

1. SLOWLY open the test gauge set valve until the gauge pointer begins to move.

2. Continue to open the valve very slowly. The pressure will increase until the check valve pops open, then will abruptly drop.

3. Note the highest pressure achieved (the “cracking" pressure).

4. Close the valve.

5. Slowly open the test gauge set valve until the pressure is just below the highest pressure (within about 5 psi) achieved in step 2, above (that is, before the valve pops open).

6. Close the valve and immediately start stopwatch. The pressure will slowly drop and remain at a lower level.

7. Stop the main drive.

8. Record the time for the pressure to drop from its highest reading to 150 psi.

9. If the pressure does not drop below 150 psi in more than 30 seconds, skip to step 11.

10. If the pressure drops below 150 psi in less than 30 seconds:

    a. Check for leaks at sealing surface between dummy injector cone and discharge head.

    b. If leaks are not evident, replace discharge head.

11. Disconnect the connecting tubing from the dummy injector.

12. Disconnect the test gauge set.

13. Drain the connecting tubing.

14. Replace the cover on the test gauge set.

15. Unclamp the dummy injector.

16. Remove the discharge head.

17. Remove the splash shield cup.

18. Reinstall the discharge head in normal position.

19. Reinstall flowmeter hose on the discharge head.

20. Return the dummy injector and the splash shield cup to the Audit Kit carrying case.

2.6 FLOWMETER CHECK

This test is not intended to check accuracy of the flowmeter but only checks that the meter is operational and in good working order. Accuracy is built into the flowmeter and more sophisticated equipment and techniques are required for such a test.

Two people are required for this test, one to fill the graduate and operate the stop watch and the other to record readings from the flowmeter display on the console.

Equipment Required

- Cummins Flow code 178A injector
- Graduated cylinder
- Container
- Stopwatch
- Paper and pencil

Set-up

1. Remove lower rear panel.

2. Install and run the injector per the CD3 calibrator instruction manual.

3. Locate flowmeter return tubing. Pull the tubing out of the reservoir, and direct the fluid flow into the container.

4. Start the main drive motor.

5. Set the RAIL PRESSURE gauge to exactly 100 psi.

6. Set the graduated cylinder on the floor next to the container.

   NOTE: *The cylinder must be empty and reasonably dry (inside) at the beginning of each test.*

7. Hold the drain tube installed in step 3 so flow will be directed into the container.

8. Select 50 strokes with the STROKES selector switch on the console.

9. Push the START METER button.

Test

10. Simultaneously direct the drain tube into the graduated cylinder and start the stopwatch.

11. Fill the graduate for 57 seconds and then direct the flow back to the container.

12. During this filling time, record the flow readings on the display. There should be about 20 readings.

13. Stop the main drive motor.

14. Average the flow readings obtained in step 11.

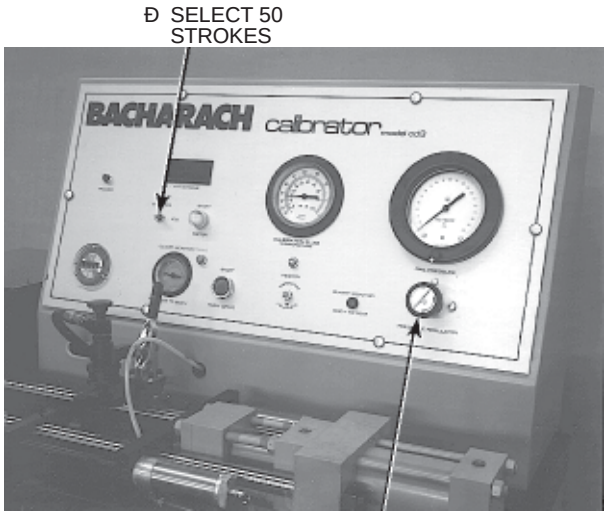


Figure 2-19. Flowmeter Check Set-up

15. Read and record the contents of the graduate while it is sitting on a level surface. Be sure to read the **bottom** of the meniscus.

16. Repeat the test three times, cleaning the graduate for each test.

Although the graduate scale is in ml or cm^3 (cc) and the flowmeter display indicates mm/stroke, the numbers should be within ±5.

For examples if the average display reading is 150.3 mm/stroke, the graduate reading should be between 145.3 and 155.3 ml.

The results should be consistent. If these results cannot be obtained, see the troubleshooting section of the CD3 manual.

17. Remove all test equipment and return it to the Audit Kit case.

18. Insert drain tube into reservoir (removed in step 3).

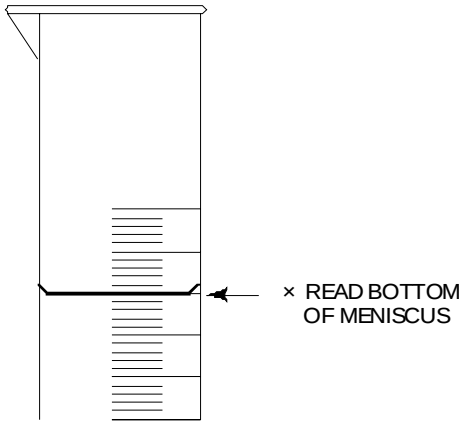


Figure 2-20. Reading Graduate

2.7 BODY TO SEAT CLAMP FORCE TEST

Proper body to seat clamping assures good sealing of the Cummins injector to the discharge head. This sealing is required because high pressure is developed between the Cummins injector and the discharge head. Low clamping force may cause leakage which in turn will affect fuel output readings.

Equipment Required

- Load cell assembly
- Clamp force and temperature indicator
- Discharge head, (Cummins)

Set-up

1. Place the flywheel in top dead center position (the white area will show through the window).

2. Place the discharge head in position.

3. Place the load cell assembly in position.

4. Connect the load cell assembly cable to the clamp force and temperature indicator.

5. Push and hold the HOLD TO OPERATE button.

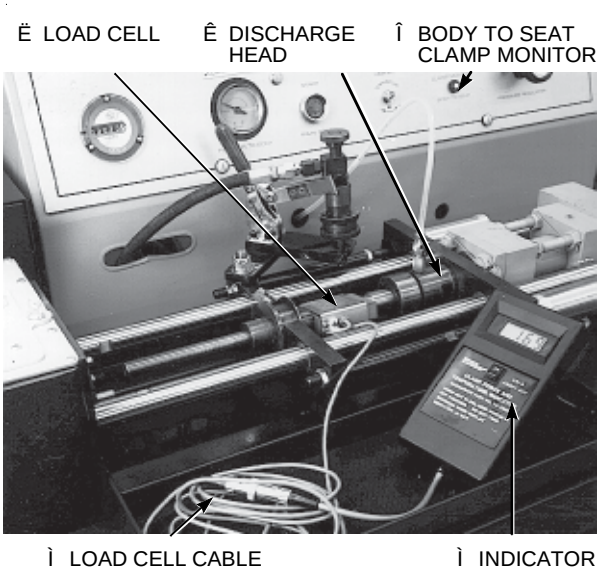


Figure 2-21. Body to seat Clamp Force Test

6. While holding the HOLD TO OPERATE button, push the BODY TO SEAT CLAMP button on the right hand side operator's control panel.

   NOTE*: The BODY TO SEAT clamp monitor located on gauge panel will appear green when the body to seat clamp is engaged.*

7. Release both buttons.

8. To unclamp the load cell, press the yellow button on the left hand side of the operator's control panel.

Test

9. Turn on the clamp force and temperature indicator.

10. Clamp the body to the seat.

11. Record the reading on the clamp force and temperature indicator.

12. Unclamp the body from the seat.

13. Repeat steps 10, 11 and 12 three times. Each reading should be a minimum of 167 pounds force.

14. If readings are too low:

    a. Check the gauge reading on the air regulator located in back of calibrator. It should be set for 60 to 65 psi.

    b. Make sure there are no air leaks in the lines supplying air to clamping cylinders or solenoids.

    c. Examine all affected parts and replace damaged or worn components.

15. Unclamp the load cell assembly.

16. Turn off the clamp force and temperature indicator.

2.8 PLUNGER TO BODY CLAMP FORCE TEST

The plunger to body clamping force simulates the force by which the Cummins injector is held in the engine. This force has an influence on the flow output of the Cummins injector. The lower the force, the higher the injector output and vice versa. The influence varies with the type of injector and deviation from the required force.

The plunger to body clamping force on GM injectors ensures proper seating of the injector against its support and sealing of the injector in the discharge head.

Equipment Required

- Load cell assembly
- Clip force and temperature indicator
- Discharge head (Cummins)

Set-up

1. Position the load cell assembly (left end) over the treated push rod extending from the cam-box.

2. Push and hold the HOLD TO OPERATE button with the left hand.

3. While holding down the HOLD TO OPERATE button, move the CLAMP/UNCLAMP lever to the CLAMP position with the right hand.

4. Wait until the CLAMP MONITOR/TIMING INDICATOR light on the gauge panel goes out (about 3 seconds).

   NOTE*: The CLAMP MONITOR/TIMING INDICATOR light is installed on all CD3 calibrators manufactured after November 1984. If the light is not on your panel, hold the button and lever for about 3 seconds.*

5. Release the HOLD TO OPERATE button first and then the CLAMP/UNCLAMP lever. The lever will return to the center position.

6. Press and hold the HOLD TO OPERATE button and move the CLAMP/UNCLAMP lever to the UNCLAMP position.

7. Wait until the cylinder with the discharge head is fully retracted.

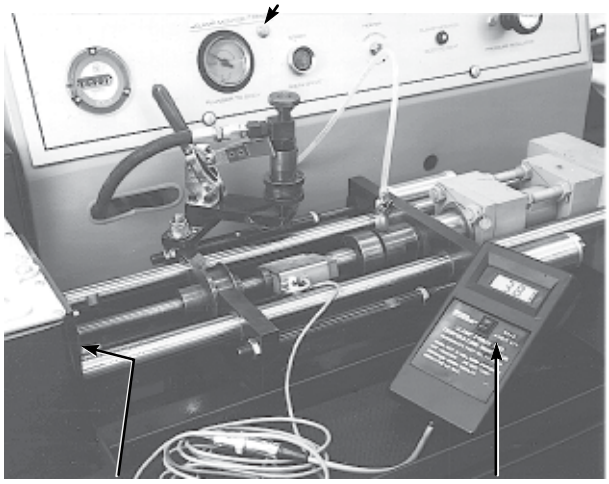


Figure 2-22. Plunger to Body Clamp Force Test

8. Release the HOLD TO OPERATE button and allow the lever to return to the center position.

9. Repeat steps 2 through 8 (clamping and unclamping) five times.

10. Connect load cell assembly to the clamp force and temperature indicator and turn on display.

Test

11. Clamp the plunger to the body.

12. Record the reading on the clamp force and temperature indicator after 2 seconds.

13. Unclamp the plunger from the body.

14. Repeat steps 1, 2, and 3 three times. Each reading must be 380 lb. ± 10 lb. force.

15. To raise or lower reading:

    a. Remove the right side cover on the stand.

    b. Turn the regulator adjustment clockwise to raise the force, counterclockwise to lower the force.

       NOTE: *Calibrators manufactured after November 1984 have a knob adjustment as shown in the photo. Loosen the locknut behind the knob before turning. Retighten the locknut after turning.*

       Older calibrators have a screw adjustment.

    c. After each adjustment, repeat the clamping operation (steps 1, 2, and 3) to see the results of adjustment.

       NOTE*: After each clamping operation, the clamping force may tend to drop slowly. A 5 lb. drop in 30 seconds is normal. If the drop is greater, replace the discharge head seal and retest.*

16. If necessary, adjust the clamp monitor gauge to be in the middle of the green area of the dial when the clamping force is 380 lb.

    NOTE: *If your clamp monitor gauge has a 0 to 160 psi dial, adjust the needle so it reads 100 psi when the clamp force is 380 lb. Support the needle with thumb and finger near its center so it will not break.*

× ADJUST CLAMP FORCE

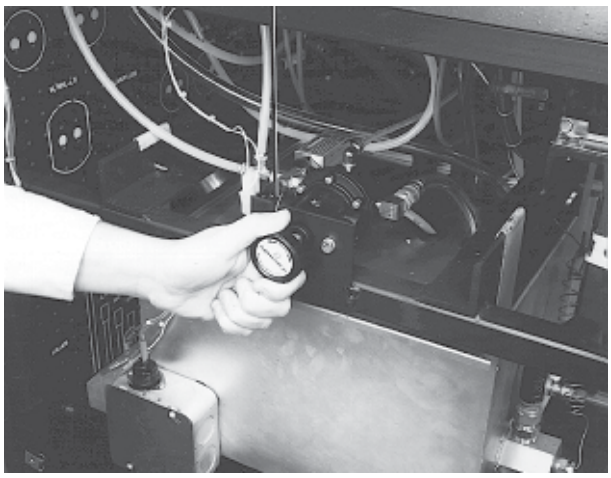


Figure 2-23. Adjusting Clamp Force

Ø ADJUST CLAMP MONITOR GAUGE

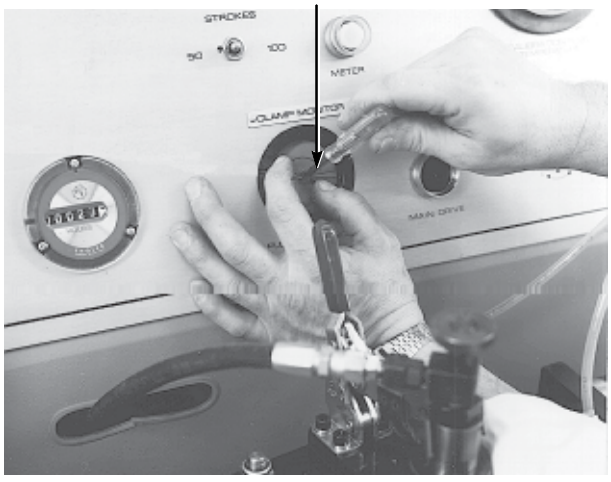


Figure 2-24. Adjusting Clamp Monitor Gauge

17. Remove the load cell assembly and turn off the clamp force and temperature indicator.

2.9 INJECTOR SUPPLY PRESSURE

The injector inlet pressure of 100 psi (for Cummins injectors) has the greatest effect on injector output flow of all test parameters. The higher the inlet pressure, the higher the injector fuel output.

Equipment Required

- Dummy injector
- Dead weight tester assembly
- Rail pressure gauge adjusting tool
- Graduate
- Stopwatch
- Tubing with quick connect
- Hose

Set-up

1. Install the dummy injector.

2. Connect plastic tubing to the dummy injector.

3. Clamp the body to the seat.

4. Clamp the fuel arm on the injector.

5. Turn PRESSURE REGULATOR knob on gauge panel counterclockwise until it turns freely.

   NOTE: *Lock nut may require loosening before knob can be turned.*

6. Connect tubing with quick connect from dead weight tester to the quick connect on the left side of the dummy injector.

7. Connect flexible tubing to the barbed fitting at the bottom of the dummy injector and direct it down the drain hole in the drain pan.

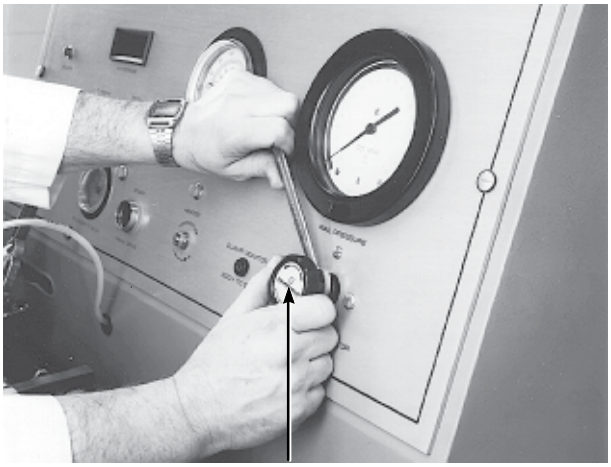
8. Push the START MAIN DRIVE button.

   NOTE: *Make sure the calibration fluid temperature shown on the gauge is at 104 °F ±1°F before proceeding.*

9. Set the dead weight tester on the drain tray.

10. Level the dead weight tester with the socket-head capscrews in the base while observing the bubble level indicator.

11. Remove trim weight from dead weight tester.



Í PRESSURE REGULATOR KNOB

Figure 2-25. Pressure Regulator Knob

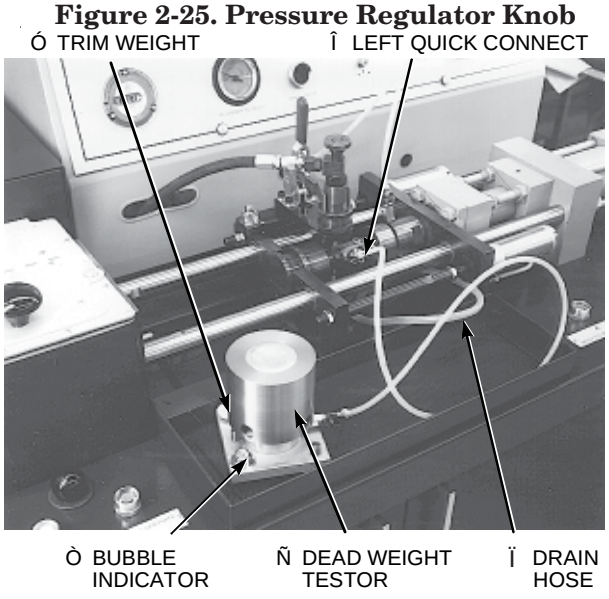


Figure 2-26. Injector Supply Pressure Set-up

12. Purge air from the line and tester by momentarily depressing the bleeder valve pin (quick connect) located 90° from the fluid inlet.

Test

NOTE: *During the test, keep the weight (top portion of the dead weight tester) spinning to reduce friction and increase accuracy. Be certain no leakage occurs around the fuel arm connection to the dummy injector.*

13. Slowly turn PRESSURE REGULATOR knob clockwise until the dead weight begins to rise.

14. Place the trim weight on dead weight tester. The weight should slowly fall.

15. Adjust the pressure regulator until both conditions (steps 13 and 14) are obtained at one setting of the regulator.

16. Remove trim weight. The weight should rise.

17. Repeat steps 13 and 14 to check setting.

18. Tighten the lock nut on the regulator while holding the PRESSURE REGULATOR knob from turning.

    After final adjustments, the console-mounted pressure gauge should read exactly 100 psi.

19. If the gauge does not read 100 psi, adjust the gauge needle as required to read 100 psi:

    a. Remove the glass over the gauge by loosening the thumbscrew on the bezel and pulling the bezel away from the gauge.

    b. Insert the rail pressure gauge adjusting tool in the hole on the needle and turn as required to set the needle at 100 psi.

    c. Remove the tool and replace the bezel.

20. Set 250 ml graduated cylinder on drain tray.

21. With the stopwatch in one hand and the drain tube from the bottom of the dummy injector in the other, fill the graduate for 20 seconds.

22. Read the volume of fluid from the scale on the graduate. Be sure to read the bottom of the meniscus. Volume should be between 176 and 179 cc(ml).

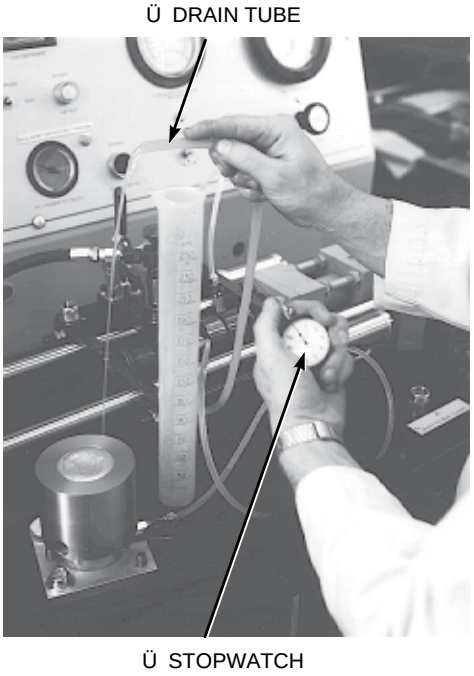


Figure 2-27. Filling Graduate

23. Repeat steps 21 and 22 two more times and take the average of the three readings. It must be between 176 and 179 cc(ml).

24. If volume is below 176 cc(ml), check for obstruction in the orifice located in the dummy injector or for a leak in the supply system.

25. Stop the calibrator (with the STOP button.)

2.10 STROKE COUNT CHECK

The following test is a verification that each update occurs after the prescribed number of strokes 50 or 100). It is based on the fact that the speed is at its nominal 1050 RPM.

Equipment Required

- Stopwatch

Set-up

1. Remove the injector, push rod, and associated accessories.

2. Set the STROKES selector to 50.

3. Push the START MAIN DRIVE button.

4. Push the START METER button.

Test

5. Using the stopwatch, note the time between flashes of the indicator light which appears in the MM^3/STROKE display.

   The flashes should be between 2.8 and 2.9 second intervals. A ± 0.05 second difference resulting from stopwatch and human error is permissible.

6. Repeat step 5 three times.

7. If the stroke interval average is not between 2.8 and 2.9 seconds consult the CD3 manual.

8. Turn off the main drive. (Push the STOP button.)

9. Return all Audit Kit equipment to its case.

Figure 2-28. Stroke Count Check

3.0 DETROIT DIESEL (DD) ENGINE INJECTORS

All the procedures described in this section are necessary to ensure accurate testing of Diesel Technology Corp. injectors used in Detroit Diesel engines (commonly refered to as **DD injectors**).

3.1 CALIBRATOR RPM TEST

This test ensures that the injectors are driven at the correct speed. Because the main motor is synchronous, the speed of the camshaft depends only on the incoming power frequency and the belt rating. As long as the frequency is held to 60 Hz (or 50 Hz, depending on the motor used), the speed will fall within the prescribed range. If an injector is driven at a lower than prescribed speed, its flow output will increase because the absolute time for filling is increased.

Equipment Required

- Hand held digital tachometer, optical preferred
- Screwdriver (small stubby)

3.1.1 Using a Photo-Electric Tachometer

Set-up

1. Switch circuit breaker OFF.

2. Open the pulley cover.

   NOTE: *Older units use a sliding pulley cover, which should be opened ½ inch.*

3. Attach a small piece of reflective tape (usually supplied with the tachometer) to the front flywheel face so that it can be seen through the perforated window.

   NOTE: *The white painted strip on the flywheel can be used instead of the tape. The painted strip can be viewed through the perforated window.*

4. Close pulley cover.

5. Turn circuit breaker on side of calibrator ON.

6. Press the START button.

Test

7. Aim tachometer lightbeam at the perforated window and read RPM. (Consult the tachometer instructions if any problems with the reading occurs.)

8. Record reading.

9. Press the STOP button.

10. If RPM is 2000 ±5 rpm, skip to step 12.

11. If RPM is not 2000 ±5 rpm:

    a. Make sure the motor matches the line frequency (see specifications on the nameplate inside left side door).

    b. Operate the calibrator without an injector installed and without push rod adapters.

    c. Recheck the speed with a tachometer.

    d. If problems still exist, check the drive shaft, pump shaft or motor shaft binding and replace necessary parts.

12. If speed is normal, turn the circuit breaker OFF.

3.1.2 Using a Mechanical Tachometer

Set-up

1. Switch circuit breaker OFF.

2. Remove the pulley cover.

   NOTE: *Older units (shown in the photos) using a sliding pulley cover (newer units have no side rails), slide the cover backward until the track is disengaged.*

3. Standing behind the machine, locate the camshaft center hole on end of camshaft.

   When performing tests, the end of the tachometer will be pressed against the end of the shaft at this point. The tachometer must be held in line with shaft center for accurate reading.

4. Locate the cover interlock limit switch on the calibrator table top just behind the drive shaft next to the cover latch plate.

Ë CAMSHAFT CENTER HOLE

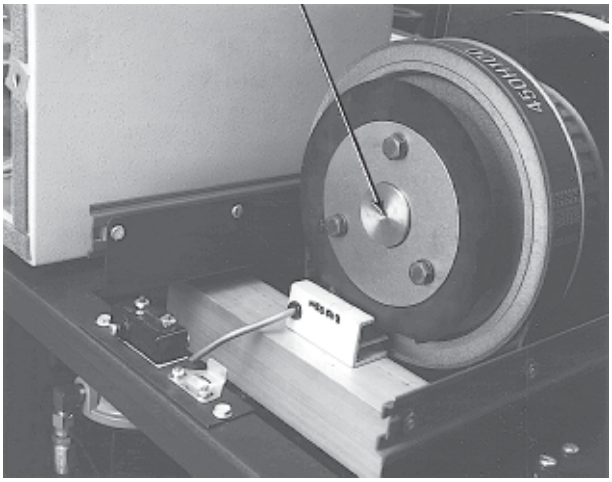
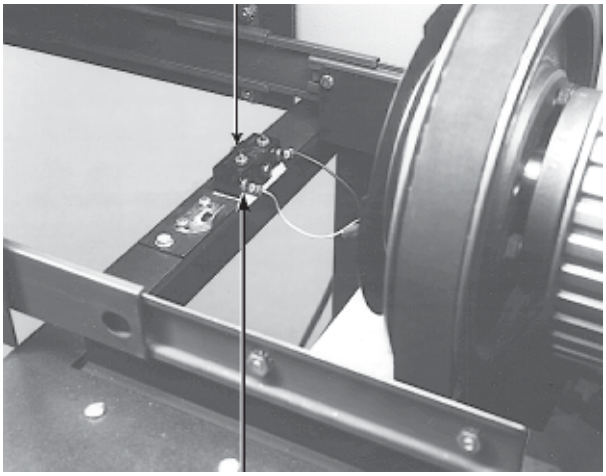


Figure 3-1. Camshaft Center Hole

Ì LIMIT SWITCH



Í RIGHT TERMINAL SCREW

Figure 3-2. Limit Switch

5. Remove the wire on the center terminal of the switch and reconnect it to the right terminal screw of the switch (as viewed from the rear of the calibrator).

6. Set the main drive belt for testing DD injectors.

7. Set up the calibrator for running a DD injector test as per the CD3 instruction manual.

WARNING

HAZARDOUS ROTATING EQUIPMENT. Do not reach over the pulley to operate the START or STOP buttons. Walk around to the front of calibrator. Beware of loose clothing as it may become entangled in rotating equipment.

8. Turn circuit breaker on side of calibrator ON.

9. Press the START button.

10. Press the end of the tachometer shaft against the back end of the camshaft and read RPM. Keep the tachometer aligned with the camshaft. Make sure that the center of the camshaft is oil-free. Oil on the camshaft will cause the tachometer shaft to slip. Inaccurate readings will result.

11. Record the reading.

12. Press the STOP button.

13. If speed is 2000 RPM ± 5 RPM, skip to step 15.

14. If speed is not 2000 RPM ± 5 RPM:

    a. Make sure the pulley and motor match line frequency (see specifications on nameplate inside left side door).

    b. Operate the calibrator without an injector installed and without push rod adapter.

    c. Recheck speed with tachometer.

    d. If problems still exist, check for drive shaft, pump shaft or motor shaft binding and replace necessary parts.

15. If speed is normal, turn the circuit breaker OFF.

Ò TACHOMETER

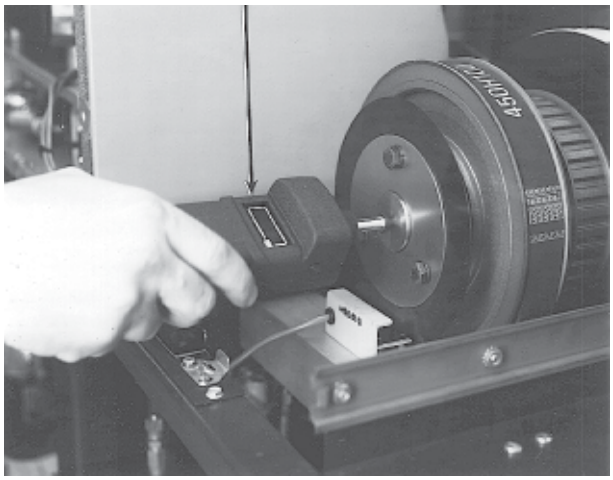


Figure 3-3. Using Tachometer

16. Reinstall the wire on the interlock limit switch in its original position, at the center screw.

17. Replace the pulley cover.

18. Turn the power switch on the site of the calibrator to ON.

19. Push the START MAIN DRIVE button on the front of the calibrator.

20. While the calibrator is operating, open the pulley cover.

    NOTE: *For older units use a sliding pulley cover, slide the cover 1/2 inch toward the back of the stand.*

The calibrator will stop automatically if wiring is correct and system is functioning properly.

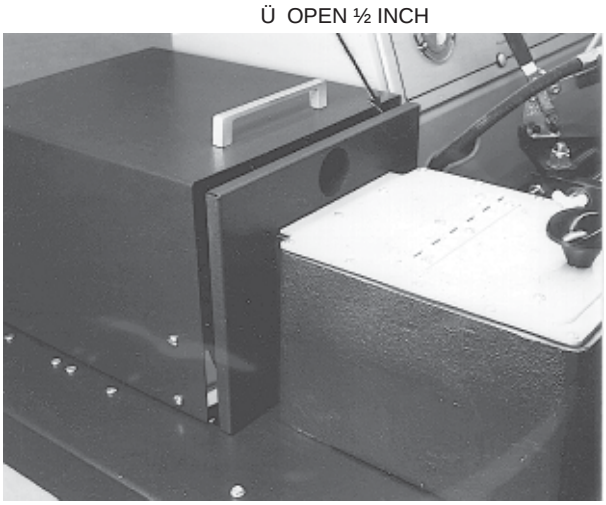


Figure 3-4. Opening Pully Cover

3.2 CALIBRATION FLUID VISCOSITY CHECK

Skip this test if you have already done it for Cummins injectors. Otherwise, follow the procedure listed in Section 2.2.

3.3 CALIBRATION FLUID TEMPERATURE TEST

Skip this test if you have already done it for Cummins injectors. Otherwise follow the procedure in Section 2.3.

3.4 FLOWMETER CHECK

Skip this test if you have already done it for Cummins injectors. Otherwise follow the procedure in Section 2.6 (using a 92 series injector), except:

- Select 100 strokes (step 8).
- Fill the graduate for 30 seconds and then direct the flow back to the container (step 11).
- There will be about 10 readings (step 12).

3.5 PLUNGER TO BODY CLAMP FORCE TEST

While the plunger to body clamp force test is not critical for DD injector flow tests, it should be checked to ensure correct seating of injectors and sealing in the discharge head.

Skip this test if you have already done it for Cummins injectors, otherwise follow the procedure in Section 2.8.

3.6 DD MASTER INJECTOR FLOW TEST

Equipment Required

- Master injectors, Kent Moore part J26298 for 53, 71, and 149 injectors
- Master injector, Kent Moore part J29898 for 8.2L injector

Set-up

1. Set up the calibrator to run DD injectors following the procedures given in the CD3 Instruction Manual.

Test

2. Run each master injector repeatedly until readings stabilize.

3. After readings stabilize, record at least five consecutive readings per injector.

IMPORTANT NOTE:

It was recognized that testing unit injectors (manufactured by Diesel Technology Corporation for Detroit Diesel Corporation (DDC) engines) the results can be different from those obtained on other makes and models of calibrators.

In particular, it has been determined that Master Injectors marketed by Kent Moore all read higher on Bacharach CD3 Calibrator by the amount shown below. Therefore, when checking Master Injectors, fuel output as read on the digital readout of the CD3 Calibrator will be higher than the stamped values by the amounts shown:

Injector Type	*Difference In Reading (mm^3/str)*
53	*2.0*
71	*2.5*
92	*4.6*
8.2L	*2.3*
149	*3.9*

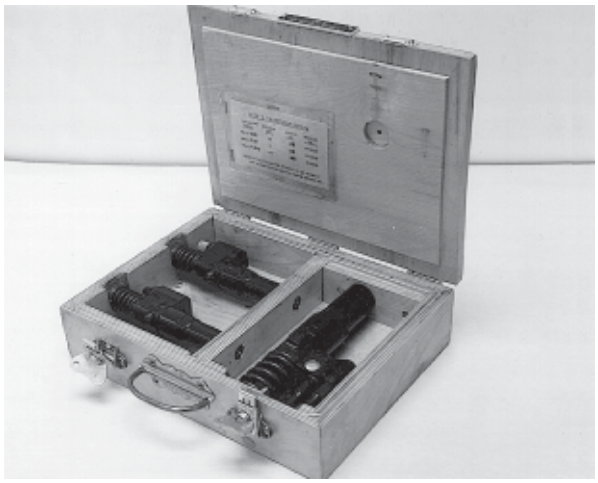


Figure 3-5. DD Master Injectors

The recheck limits (as given by DDC) of Master Injectors on any calibrator are ±2% of stamped value. As an example, for the type 71 Master Injector:

Stamped Value		*Add*		*Correct Value*	*Tolerance (2%)*
72.0	+	*2.5*	=	*74.5*	*73.0 - 76.0*

Therefore, for a type 71 Master injector stamped as 72.0, correct delivery value (fuel output) should be 73.0-76.0 mm^3/str on a Bacharach CD3 Calibrator.

From the above it follows that when calibrating and/or checking injectors in service it is necessary to add the above numbers to the limits given by the manufacturer. For example:

Injector N75 (part No. 522877) has limits for the KM Calibrator of 75 - 80 mm^3/str. On the CD3 it is necessary to add 2.5. Therefore, the new limits are 77.5 - 82.5 mm^3/str.

4. Compare the average obtained with the value stamped on the master injectors. The readings must be within ± 2% of the number stamped.

3.7 STROKE COUNT CHECK

The following test is a verification that each update occurs after the prescribed number of (50 or 100) strokes. It is based on the fact that the speed is at its nominal 2000 RPM.

Skip this test if you have already done it for Cummins injectors.

Equipment Required

- Stopwatch

Set-up

1. Remove the injector, push rod, and associated accessories.

2. Set the STROKES selector to 100.

3. Push the START MAIN DRIVE button.

4. Push the START METER button.

Test

5. Using the stopwatch, note the time between flashes of the strokes indicator which appears in the MM³/STROKE display.

   The flashes should be at 3.0-second intervals.

6. Repeat step 5 three times.

7. If the stroke interval average is not 3.0 seconds consult the CD3 manual.

8. Turn off the main drive. (Push the STOP button.)

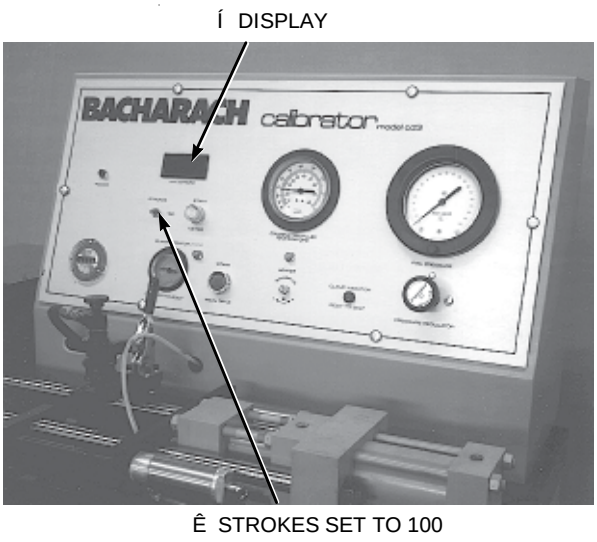


Figure 3-6. Stroke Count Check

NOTES

4.0 POST AUDIT CHECKLIST

Checklist for completed audit	**YES**	**NO**
Calibration fluid viscosity is per chart supplied with the Viscor cup.	_____	_____
Calibration fluid temperature is 104°F + 1°F.	_____	_____
Gear pump pressure is between 400 and 410 psi.	_____	_____
Body to seat clamp force is more than 167 lbs.	_____	_____
Plunger to body clamp force is 380 lb ± 10 lbs.	_____	_____
Injector supply pressure is exactly 100 psi.	_____	_____
Flow from dummy injector orifice is between 528 and 537 cc/min.	_____	_____
Discharge head upstream pressure is above 300 psi for 60 seconds minimum.	_____	_____
Discharge head pressure drop is 150 psi +20, -0 psi.	_____	_____
Discharge head downstream pressure is above 150 psi for 30 seconds minimum.	_____	_____
Camshaft speed for Cummins is 1050 rpm ± 1 rpm.	_____	_____
Camshaft speed for GM is 2000 rpm ± 5 rpm.	_____	_____
Strokes occur at between 2.8 and 2.9 second intervals (STROKES set at 50 and speed set at 1050 RPM).	_____	_____

Return all calibration tools and equipment to the Audit Kit box or to their proper positions on the calibrator doors.

CAUTION

Leaks from batteries can damage the indicator. Remove batteries from the indicator, especially if the indicator will be stored for more than a few days.

NOTES

5.0 SPARE PARTS

5.1 MAJOR ASSEMBLIES

Item	Description	Part no.
1	Dead weight tester assembly	77-0466
2	Test gauge set	77-0467
3	Viscor cup with instructions	77-0391
4	Dummy injector assembly	77-0468
5	Clamp force and temperature indicator	77-0423*
6	Temperature transducer assembly	77-0469*
7	Load cell assembly	77-0470*
8	Splash Shield Cup (consists of):	
	Plastic Closure	05-3166
	Poly. Tubing	03-6019

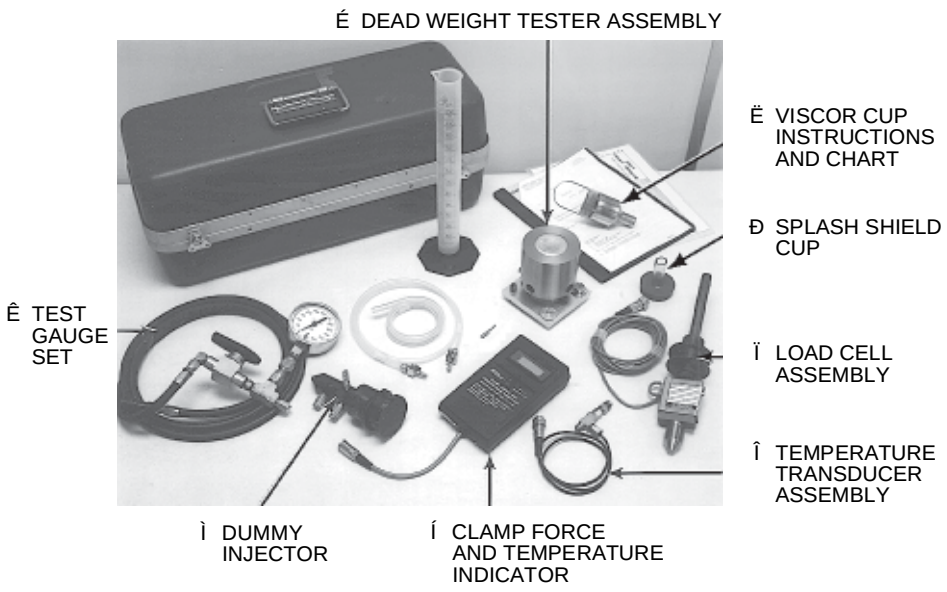

É DEAD WEIGHT TESTER ASSEMBLY
Ë VISCOR CUP INSTRUCTIONS AND CHART
Ð SPLASH SHIELD CUP
Ê TEST GAUGE SET
Ï LOAD CELL ASSEMBLY
Î TEMPERATURE TRANSDUCER ASSEMBLY
Ì DUMMY INJECTOR
Í CLAMP FORCE AND TEMPERATURE INDICATOR

Figure 5-1. Major Assemblies of the CD3 Audit Kit

*** NOTE:** *The Clamp force and temperature indicator is calibrated for an individual load cell assembly and temperature transducer assembly. The three items become a matched set. If a problem with any of these items is suspected, return the indicator to Bacharach for calibration.*

5.2 INDIVIDUAL REPLACEMENT PARTS

Item	Description	Part no.
1	Case, without inserts (tap and bottom plate)	24-0117
2	Graduated cylinder, 250 ml (cc)	06-5492
3	Gauge adjusting tool	77-0461
4*	Quick connect socket on dead weight tester	103-5396
5	Load cell push rod adapter	77-0384
6	Load cell adapter	77-0383
7	Load cell discharge head adapter	77-0385
8	Connectors, str. shell 7-pin (on load cell and temperature transducer)	204-1681
9	Quick connect insert	103-5391
10	Flexible tubing, 1/4" OD (order by foot)	03-2912
11	Connector for indicator	204-1680
12	Quick connect socket on dummy injector	67-6660
13	Quick connect socket, 1/4"	03-5400
14	Ball valve	03-4275
15	Shut-off coupling socket	03-5351
16	High pressure hose for test gauge set	72-0414
17	Pressure gauge, 0-600 psi	77-0395
18	Flexible hose, Tygon, 1/4"ID (order by foot)	03-6063
19*	Nut with brass sleeve (1/4"OD tubing) (part of item 10)	03-2962
20*	Sealing washer for discharge head	900-6091

* Not Shown

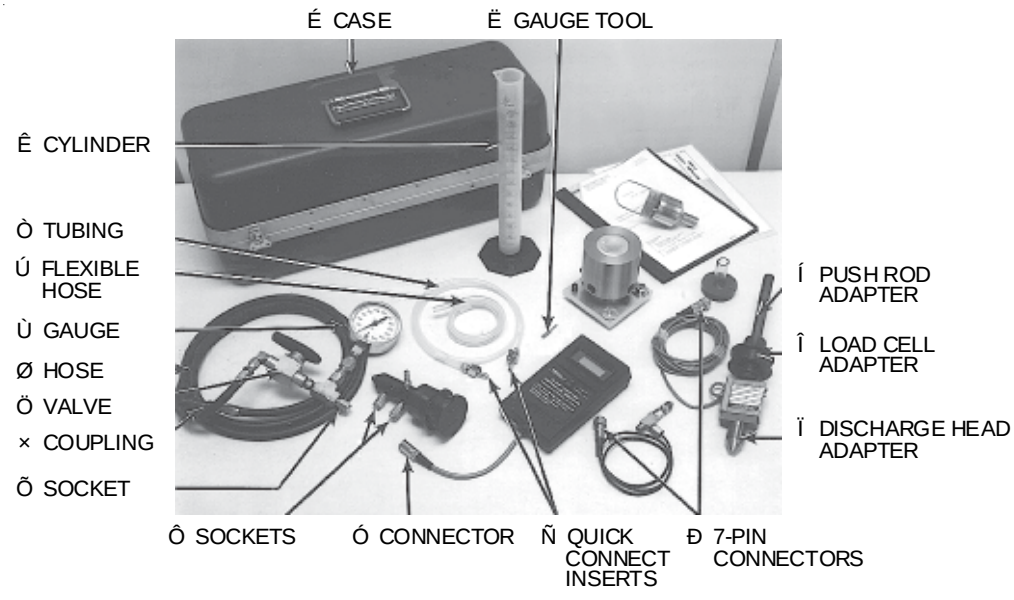


Figure 5-2. Individual Replacement Parts